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IP Indian Journal of Library Science and Information Technology

Journal homepage: https://www.ijlsit.org/

Review Article

The role of technology in disaster preparedness for digital collections in libraries

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ARTICLE INFO

Article history:
Received 18-11-2023
Accepted 08-12-2023
Available online 16-01-2024

Keywords:
Digital Assets
Preservation
Security
Future Trends

ABSTRACT

In the digital age, libraries have transitioned from being repositories of printed materials to custodians of vast digital collections, including manuscripts, photographs, research data, and cultural artifacts. The preservation of these digital collections is vital for the continuity of our cultural and academic heritage.
The purpose of the study to highlight how technology plays a pivotal role in disaster preparedness for digital collections in libraries. It delves into the unique challenges digital materials face, such as hardware failure, cyber threats, and obsolescence, and highlights the ethical and legal considerations.
Through case studies and best practices, it showcases how libraries are harnessing technology, including cloud storage, digital asset management systems, and backup protocols, to mitigate risks and ensure data continuity.
This research underscores the increasing significance of technology in safeguarding digital collections, offering practical recommendations and insights for libraries seeking to protect their digital heritage.

1. Introduction

Libraries have always stood as guardians of human knowledge and culture. Traditionally, their role was to preserve printed manuscripts and books. Yet, the information landscape has witnessed a profound transformation, shifting from the tangible to the intangible, from physical to digital. The 21st century has ushered in a new era in which libraries are not only curators of printed works but also stewards of extensive digital collections. The digital realm houses our cultural and academic heritage in the form of rare manuscripts, historic photographs, research datasets, and more. This transition represents not merely an expansion of libraries' purview but also a profound shift in their responsibility. As the custodians of digital heritage, libraries must now grapple with the immense challenge of preserving digital collections against the ever-present threats of disasters, both physical and digital.

This paper is dedicated to exploring a critical facet of modern library science: the role of technology in disaster preparedness for digital collections in libraries. It delves into how technology has become the linchpin of contemporary library practice, allowing libraries to confront the intricate challenges associated with preserving their digital treasures. By the end of this exploration, it will become clear that the preservation of digital collections is not merely a technical concern; it is a matter of safeguarding the cultural and academic heritage of society. The significance of this paper extends beyond the preservation of digital assets; it encompasses the preservation of knowledge, culture, and the very essence of a society in the digital age.

1.1. Significance of the study

In this study we examine the critical role technology plays in preserving and safeguarding digital collections

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https://doi.org/10.18231/j.ijlsit.2023.015

within libraries against various disaster scenarios. As libraries have transitioned from being primarily repositories of physical materials to curators of extensive digital collections, the risks and challenges associated with digital preservation have grown. This paper explores how libraries are harnessing technology to develop robust disaster preparedness strategies to protect their digital assets.

2. Literature Review

Khalid & Dol (2015) studied to assessed disaster preparedness in academic libraries in Malaysia, specifically in Selangor and Kuala Lumpur. It reveals that some libraries have experienced disasters but lack written disaster preparedness plans. Risk assessments and staff involvement in disaster preparedness are generally adequate.[1] According to Ayoung et al (2016) libraries should establish disaster management policies, conduct staff training for disaster awareness, and actively engage in cooperative networks for effective disaster preparedness.[2] Rachman & Afidhan (2018) highlights the limited literature on digital disaster preparedness in libraries in Indonesia. It emphasizes the need for policies and protection measures for digital collections as they grow. Libraries should develop preservation policies and disaster management plans.[2] Hussain (2019) investigated disaster preparedness in ten prominent libraries in Jammu & Kashmir. Author found a lack of staff awareness and preparedness, with none of the libraries adequately ready for disasters. The study reveals a deficiency in disaster preparedness plans and teams, highlighting the need for improvements in this aspect.[3] Rachman (2020) study on Indonesian academic libraries highlights the growing vulnerability of digital collections. While some protection measures are in place, many lack formal digital disaster preparedness policies and risk assessments. The study recommends conducting risk assessments to mitigate potential disasters.[3] Study done by Lio et al (2020) in Nigerian university libraries shows that librarians view disaster preparedness as crucial for effective preservation and conservation of resources. It also highlights the need for comprehensive preservation strategies.[4] Chiderah & Iroeze (2021) Assesses disaster preparedness in academic libraries in South-eastern Nigeria, highlighting a lack of written disaster plans, inadequate preparedness measures, and limited staff involvement. Recommendations include developing written plans, implementing preparedness measures, and involving library staff in disaster management.[5] Oketch & Wamae (2021) evaluated disaster preparedness in Egerton University's digital library, emphasizing the low level of preparedness, inadequate training, and lack of equipment. The study recommends improved support, policy development, and structured staff training in disaster preparedness and planning.[6] Research explored by Chizwina & Ngulube (2021) revealing a lack of formal disaster management within their collection policies for disaster preparedness in South African community libraries. Disaster management needs integration into collection development.[7] Study done by Iroeze & Iroeze (2021) indicated a high likelihood of disasters like fire, flood, heat, insects, and leakage in South-eastern academic libraries. Most lack a disaster plan, demonstrating very low preparedness. Risk assessment and disaster response teams are also insufficient.[8] Tukur (2022) found that selected academic libraries in Gusau, Zamfara State have acquired equipment for disaster prevention and response, but lack sufficient measures for disaster management. Constraints in disaster preparedness were identified.[9]

In the global literature focused on digital disaster management, notable examples encompass works ranging from McGovern and Stuchell's (2014) to Mallery's publication titled "Technology, Disaster Response, and Planning" (2015), as well as Schmidt's (2010) article addressing the challenges linked to the loss of digital communication infrastructure, including intranets, email systems, and servers.[10,11] Another noteworthy instance is the "Lots of Copies Keep Stuff Safe" (LOCKSS, 2018) model for digital preservation. This model integrates implicit disaster planning strategies within its framework, including the identification of threats, as discussed by Frank and Yakel (2013) and by Rosenthal et al (2005).[12–14] Brown (2018) verified the viability and advantages of an all-encompassing plan, serving as a comprehensive source of disaster-related information. The findings of this research may potentially hold significance for enhancing the protection of hybrid collections within the global cultural heritage sectors.[15]

While existing literature often emphasizes a noticeable gap between physical and digital disaster management, several sources do make allusions to both physical and digital formats, as well as digital infrastructure. For instance, studies conducted by Kahn (2012), Ifijeh et al (2016, p. 534–559), as well as Robertson (2015, p. 19–20), primarily concentrate on physical collections but also incorporate mentions of digital collections and their associated infrastructure, highlighting the importance of backup and restoration procedures.[16–18] The National Archives of Australia (NAA) includes references to digital archives in its recovery plan (NAA, 2010, p. 17), and the Blue Shield Australia (BSA) website (2018) identifies database failures as a potential cause of harm to cultural heritage.[19,20]Low digital curation awareness, hindered by policy gaps, staff expertise, and funding issues found by Ndhlovu (2018) and urges library to prioritize training and responsibility for future digital collection access.[21]

3. Objectives

The main objective of the paper was to study the role of technology in disaster preparedness for digital collections

of libraries, challenges in digital collection preservation, technological solutions for disaster preparedness, best practices, ethical issues and future trends of technology.

3.1. Digital collection preservation challenges

The preservation of digital collections in libraries presents a myriad of distinctive challenges, emphasizing the pivotal role of technology in disaster preparedness. These challenges encompass not only traditional physical disasters but also a host of digital threats, necessitating innovative strategies for digital collection preservation:

1. ***Hardware and Storage Failures:*** Digital collections are intimately linked to hardware and storage devices, which are vulnerable to failures such as server crashes and disk malfunctions, posing immediate risks to digital assets.
2. ***Data Integrity and Data Corruption:*** Over time, digital files can suffer from data corruption, leading to potential data loss or inaccuracies, demanding mechanisms for continuous monitoring and correction.
3. ***Cyber security Threats:*** Digital collections are susceptible to an array of cyber security threats, including hacking, malware attacks, and ransom ware incidents, necessitating comprehensive security measures and response plans.
4. ***Obsolescence of File Formats and Software:*** Digital assets often rely on specific file formats and software for access. As technology evolves, the obsolescence of these formats can render older digital materials inaccessible, requiring ongoing format migration and preservation efforts.
5. ***Scalability and Storage Costs:*** As digital collections expand, managing and storing vast amounts of data becomes a logistical challenge, entailing considerations of scalability and the associated storage costs.
6. ***Metadata Management:*** Metadata is vital for organizing and retrieving digital content, necessitating the consistent maintenance of comprehensive and accurate metadata records.
7. ***Legal and Ethical Considerations:*** Legal and ethical concerns, including intellectual property rights, data privacy regulations, and data protection laws, pose complex challenges to digital collection preservation, requiring adherence to relevant laws and ethical standards.
8. ***Migration and Format Conversion:*** To combat format obsolescence, libraries may need to migrate digital collections to new formats or convert files, a resource-intensive process that may entail potential data loss or degradation.
9. ***Long-Term Storage Costs:*** Sustaining the long-term preservation of digital assets comes with significant expenses related to storage, migration, and ongoing maintenance, posing budgetary challenges for libraries.
10. ***Access and Retrieval in Emergency Situations:*** Disaster preparedness extends to ensuring that digital collections remain accessible during and after disasters, requiring the provision of emergency access to digital materials for continuous user service and data recovery.

Addressing these preservation challenges necessitates a comprehensive approach, encompassing not only technology but also robust policies, well-trained staff, and a proactive commitment to the continuity and accessibility of digital cultural and academic heritage.

4. Technology Solutions for Disaster Preparedness for Digital Collection

In the realm of disaster preparedness for digital collections in libraries, technology emerges as a cornerstone, offering multifaceted solutions to mitigate risks and ensure the integrity of digital assets. One key solution is cloud storage, providing secure off-site redundancy and scalability. By safeguarding digital content in geographically dispersed data centers, cloud storage minimizes the vulnerability to physical disasters and hardware failures, enabling efficient data recovery. Digital asset management systems (DAMS) play a pivotal role in cataloging and organizing digital content, streamlining retrieval processes and enhancing disaster recovery efforts. DAMS not only aid in organizing digital assets but also maintain comprehensive metadata, facilitating content search and retrieval during emergencies.

Robust backup protocols, encompassing regular data backups and versioning, offer additional layers of protection. These protocols reduce the risk of data loss in the event of hardware failures or data corruption. Advanced monitoring and alert systems, combined with real-time threat detection, strengthen cyber security and bolster libraries' ability to respond swiftly to potential breaches. Moreover, technology-driven disaster recovery plans automate data restoration, minimizing downtime and ensuring the rapid resumption of services. These technological solutions collectively empower libraries to proactively manage the distinctive preservation challenges of digital collections, ensuring their resilience in the face of disasters and the continuous accessibility of our shared digital heritage. Present various technological tools and strategies that can be employed for disaster preparedness in libraries.

5. Best Practices for Disaster Preparedness for Digital Collection

Best practices for disaster preparedness in the realm of digital collections in libraries revolve around proactive measures, efficient response strategies, and continuous

improvement.

1. ***Comprehensive Disaster Preparedness Plan:*** Libraries should formulate and regularly update comprehensive disaster preparedness plans that address various types of potential disasters. These plans should incorporate technology-driven solutions and define clear roles and responsibilities for library staff.
2. ***Robust Data Backup and Redundancy:*** Implementing regular data backups, versioning, and off-site storage through cloud solutions ensures data redundancy and minimizes data loss in case of hardware failure or data corruption.
3. ***Real-time Monitoring and Alert Systems:*** Utilizing advanced monitoring tools and alert systems aids in real-time threat detection, enabling libraries to respond swiftly to potential breaches or disasters.
4. ***Digital Asset Management Systems (DAMS):*** Deploying DAMS facilitates efficient organization and retrieval of digital content. DAMS should include comprehensive metadata to aid in content search and recovery.
5. ***Regular Training and Drills:*** Libraries should provide ongoing training to staff on disaster preparedness and recovery procedures. Conducting regular disaster drills and simulations ensures that staff is well-prepared for actual emergencies.
6. ***Ethical and Legal Compliance:*** Adhering to ethical standards, intellectual property rights, and data privacy laws is crucial. Libraries should ensure that disaster preparedness and recovery practices are in compliance with relevant regulations.
7. ***Collaboration and Communication:*** Collaborating with local emergency services, other libraries, and cultural heritage institutions enhances disaster response and recovery efforts. Effective communication plans and protocols should be in place.
8. ***Continuous Evaluation and Improvement:*** Regularly assess the effectiveness of disaster preparedness measures and identify areas for improvement. Libraries should adapt to emerging technologies and address evolving risks.

By implementing these best practices, libraries can effectively leverage technology to enhance their disaster preparedness efforts, safeguard their digital collections, and ensure the accessibility and continuity of our cultural and academic heritage.

6. Ethical and Legal Considerations

Ethical and legal considerations are integral to disaster preparedness for digital collections in libraries, shaping both the strategies and the ethical responsibilities of institutions.

1. ***Intellectual Property Rights:*** Libraries must respect copyright laws and intellectual property rights when preserving and recovering digital materials. Compliance with licensing agreements, fair use, and fair dealing principles is essential.
2. ***Data Privacy:*** Ethical and legal frameworks around data privacy necessitate rigorous measures to protect sensitive and personal data contained within digital collections. Libraries should secure data and adhere to data protection laws.
3. ***Cultural Sensitivity:*** Specialized libraries with culturally sensitive materials must consider the ethical implications of disaster preparedness. Cultural heritage, traditional knowledge, and sacred materials require unique preservation and recovery protocols.
4. ***Legal Obligations:*** Libraries may be subject to legal obligations in the event of data breaches or disasters. Understanding these obligations and having mechanisms in place to respond appropriately is crucial.
5. ***Accessibility and Inclusivity:*** Disaster preparedness plans should also ensure the continued accessibility of digital collections to all, including individuals with disabilities. Ethical considerations include making digital materials inclusive and accommodating.
6. ***Transparency and Accountability:*** Libraries should maintain transparency in their disaster preparedness practices. This includes documenting strategies, disaster response efforts, and data breaches, fostering accountability.

Examine ethical and legal issues related to digital preservation, including data privacy and copyright concerns.

7. Future Trends and Emerging Technologies

In the ever-evolving landscape of digital collection preservation, libraries are confronted with an array of future trends and emerging technologies that hold the potential to revolutionize disaster preparedness strategies. Artificial Intelligence (AI) and Machine Learning are at the forefront, enabling libraries to automate disaster detection, predict vulnerabilities, and optimize data recovery. Block chain technology offers an immutable and decentralized ledger system, ensuring the integrity and authenticity of digital assets, a promising avenue for disaster recovery. Born-digital materials, like emails and social media content, necessitate innovative preservation strategies as they become increasingly prevalent. Advanced metadata standards are streamlining content organization and retrieval, enhancing disaster recovery efforts. Libraries are also adopting sustainability initiatives to reduce their carbon footprint while deploying collaborative disaster networks and AI-driven risk assessments to bolster disaster response capabilities. Quantum computing, though in its infancy,

promises exponential advancements in data recovery and encryption. Adapting to these emerging trends is essential for libraries seeking to fortify their disaster preparedness and ensure the continued preservation and accessibility of their digital collections.

8. Conclusion

This paper explores the critical role of technology in disaster preparedness for digital collections in libraries. It delves into the challenges of preserving digital assets, such as hardware failures, data corruption, and cyber threats. The study addresses ethical and legal considerations in digital preservation, including data privacy and copyright concerns. It also examines future trends and emerging technologies, such as AI, block chain, and quantum computing, that are reshaping disaster preparedness strategies. By highlighting best practices and practical recommendations, this paper emphasizes that the preservation of digital collections is not just a technical concern but a matter of safeguarding cultural and academic heritage. It underscores the growing significance of technology in protecting digital assets and ensuring knowledge continuity in the digital age.

9. Source of Funding

None.

10. Conflict of Interest

None.

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Cite this article: Somvir, Kumar V, Kaushik S. The role of technology in disaster preparedness for digital collections in libraries. *IP Indian J Libr Sci Inf Technol* 2023;8(2):88-92.